Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 96 (2013) 2662 – 2666

Procedia
Social and Behavioral Sciences

13th COTA International Conference of Transportation Professionals (CICTP 2013)

COM component technology based batch gray images mosaic method

Xin Liu [a], Wang Hua [a]*, Wei Quan[a], Shen Zhang[a]

[a]*School of Transportation Science and Engineering, Harbin Institute of Technology, No.73 Huanghe Rd. NanGang Dist, Harbin,15001,China*

Abstract

In this paper, we present a gray image mosaic component design method based on the vector rotating relax matching algorithm, which can handle batch images fast and with high quality. We compute the coordinate transformation matrix for full-scene image splicing by using the image matching algorithm. The algorithm's matrix operation implementation is based on the COM component technology toolbox in Matlab 7.0. We apply both fuzzy human visual restriction conditions for splicing images and the multithread technology in the VC development environment to improve the matching algorithm's performance efficiency. The experiment part demonstrates the execution efficiency of the proposed method, which shows that it can meet the real-time demand of the batch gray image mosaic software system.

Selection and peer-review under responsibility of Chinese Overseas Transportation Association (COTA).

Keywords: image mosaic; image registration; relaxation matching.

1. Introduction

Full scene image software based on image splicing attracts great attention recently, such as ArcSoft Panorama Maker, PhotoShop 8.0 etc. This software are often used to process image captured by the commercial camera or personal camera, which has high image quality. However, that software is not suitable for the camera which is often used in high speed mode, complex and harsh shooting conditions, such as industrial cameras. The image quality and image fidelity captured by industrial cameras are not as good as those captured by the personal camera or commercial camera, which more or less have different degrees of image distortion and reduce the accuracy and stability of the automatic image mosaic algorithm(Liu, 2007).

Because the main difficulty of image splicing lies on image registration, researchers put great attention on image registration technology in the past decades, and have achieved significant research results (Kanazawa &

* Corresponding author. Tel.: +86-451-86283036; fax: +86-451-86283779.
E-mail address: wanghua@hit.edu.cn

Selection and peer-review under responsibility of Chinese Overseas Transportation Association (COTA).
doi:10.1016/j.sbspro.2013.08.298

Kanatani, 2004; Miranda-Luna, Daul, Blondel, Hernandez-Mier, Wolf and Guillemin, 2008; Zitová & Flusser, 2003). To improve the image registration accuracy, a large sum of matrix operations are performed on the images, which is high computation cost, and reduces the efficiency of the image splicing software. This cannot meet the real time system demanding, and the execution efficiency oversteps the user's mental endurance limit. Hence, these algorithms cannot extend to the realistic applications.

Image registration algorithm based on vector rotating relax has been proven to be a precise and robust image matching algorithm (Wang, Hou, Cong, and Sun, 2010). However, in order to pursue the above two characteristics, this kind algorithm also involve many matrix operations, and the execution efficiency is not high. To overcome this bottleneck, in this paper, we proposed a method that uses multithread technology to optimize the image registration matrix, and to execute concurrently, which can meet the real-time demanding of the image registration system.

2. Related Theories

2.1. Relax matching algorithm based on the vector rotating

Wang, Hou, Cong, and Sun (2010) proposed the relax matching algorithm based on the vector rotating, and the main idea is as follows: First, evaluate the two pairs of initial matching corner points extracted from two images; Second, involve another pair of corner points, and if the vector rotation angles of the this pair corners and that of the initial pairs of corners are very similar, support degree of this pair corner points and the two initial pairs of corner points is high. If the sum the support degree of pairs of corner points, which are constituted by one corner point with all other points, this corner point is wrong, and we can delete it. We repeat this process until all selected corner points meet the above conditions.

2.2. Fuzzy human visual restriction conditions

We can extract three main visual restriction conditions for the images to be spliced, from the vector rotating relax matching algorithm.

1. Proportional band of the overlap parts between images
2. The similarity of the grey level or the threshold between the images.
3. Subjective visual image distortion degree of the images.

Because of the differences between the images in the real world, the above three conditions in the real image process project cannot be consistent exactly, although we can get approximate values based on analysis of plenty of image data. However, this strategy will reduce the execution efficiency of the system, which is not suitable for the real world applications. On this other hand, in many industrial conditions, there is some certain pattern for the image sequences selected. For this kind of image sequences, the above three condition are usually applicable.

2.3. Software designation for the fast image registration

The image registration algorithm in Sec. 2.1 contains three main steps: Firstly, extract Harris corner point matrix for the two images to be spliced; secondly, initial circular projection matching; thirdly, relax optimization matching. The computing process of the three steps is corresponding to the above three conditions. Hence, we can improve the execution efficiency of the algorithm and the robustness of the system by reasonably using these fuzzy visual restriction conditions.

The flowchart of the image registration algorithm proposed in Sec. 2.1 is shown in Fig.1 (a). We can see from Fig.1 (a) that, there is no relevance between Step 1 and Step 2, and every individual extraction is based on the whole image. This will produce plenty of useless corner points, which are a waste of time and will cause interference for the initial matching. For the corner point matrixes selected from Step 3 and Step 5, there is relevance, but there is no relevance for the corner points within the matrix. Hence, the computation of grey similarity of the corner points and that of the support degree summation of the optimization selection algorithm can be executed concurrently.

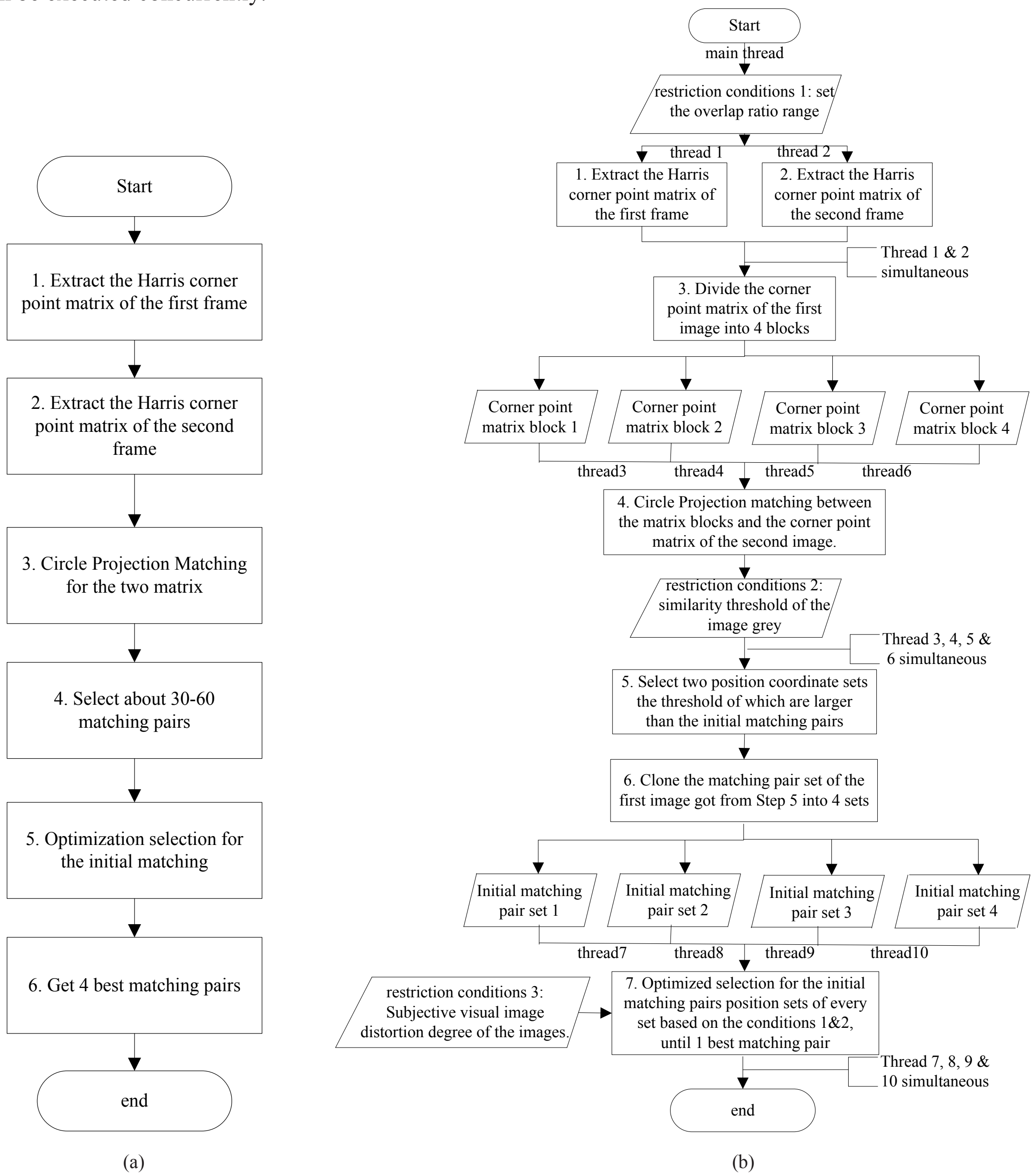


Fig.1 (a) Flowchart of the image registration algorithm; (b) Software implementation of the image registration algorithm

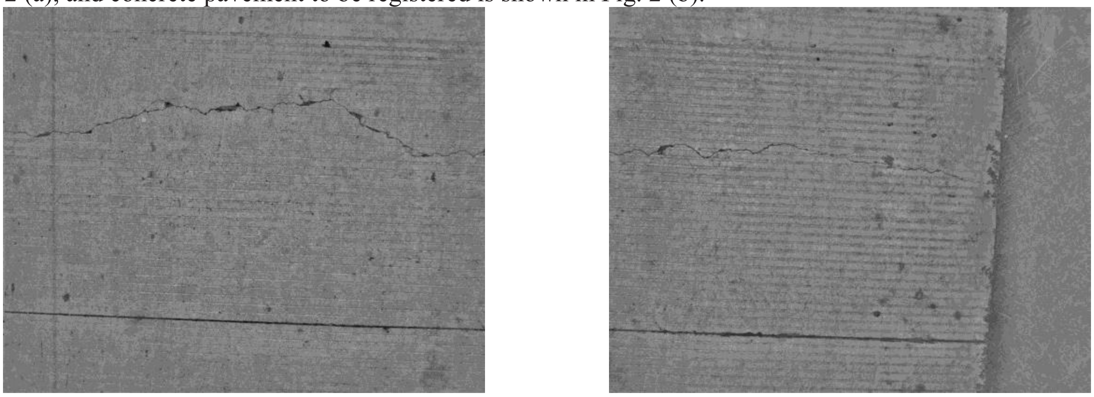
The flowchart of the software for the image registration proposed in Sec. 2.1 is shown in Fig.1 (b). Fig.1 (b) shows that, the computation time of Step 1 and Step 2 can be overlap, and the corner points searching from the un-overlap area can be avoided based on the restriction condition 1, which can improve the efficiency of the feature points searching algorithm, and the accuracy of the initial matching. Step 3 divides the corner point matrix got from Step 1 based on columns of the matrix. In this paper, we divide it into 4 blocks based on the height of the simulation image (1280×1024). All the corner point matrix blocks compute the grey similarity concurrently, and select the initial corner point matching pairs based on the restriction condition 2. Step 6 clones the initial matching pair position coordinate set of the first image to be spliced got from Step 5 set into 4, and each set will be relax matching optimization selected based on the following strategy.

Let the elements of the set be n, and the elements of the set x (x=1, 2, 3), the initial matching pairs' position coordinates of which need to be selected based relax matching optimization algorithm, belong to the region: (x-1)×[n/4]-[n/4]×x, and that of the set 4 belongs to 3×[n/4]-n.

Through this way, each set just needs to keep one best corner points matching pair, and also, in the next image splicing step, the corner point matching pairs of SVD coordinate transformation can cover the whole image in the image space. In addition, this method can guarantee the coordinate transformation of image splicing matrix to be accurate. Based on the restriction condition 3, users can set the image distortion tolerance degree values themselves through fuzzy visual feelings, which can improve the robustness of the system significantly.

3. Simulation Results

In this paper, the pair of images to splice is randomly selected from the Heilongjiang Province highway concrete pavement splicing samples. These samples are captured by an automatic road detection vehicle, which runs at the speed of 70km/h. This size of the image is 1280×1024. Concrete pavement for reference is shown in Fig. 2 (a), and concrete pavement to be registered is shown in Fig. 2 (b).



(a) (b)

Fig.2 (a) Concrete pavement for reference; (b) Concrete pavement to be registered

We make the flowchart of image registration algorithm as shown in Fig. 1 (b) as a COM component interface in Matlab 7.0, and call these interface functions in VC 6.0 to calculate the execution time of the algorithm. The machine configuration used in this work is as follows: Intel Core2 Duo processor T6600 (2.2GHz, 800MHz FSB), 2 GB Memory. The computation time of the proposed algorithm is summarized in Table 1.

From table 1 we can see that, under the above experimental settings, the proposed algorithm can finish the image registration in about an average 20s, which is acceptable for the customers. Another convincing point is that the multithread technology can make full use of the CUP resource. As the multi core CUP is on a daily broadening scale, multithread technology which executes data operation concurrently will be the trend. The execution efficiency of the image splicing algorithm based on multithread technology will continue to improve as the continuous upgrade of CUP technology.

Table 1. Computation time of the image registration algorithm as shown in Fig.1 (b)

Experiment times	Corner Point Extraction	Circle Projection Matching	Optimization selection algorithm	Total
1	4.766	15.188	0.421	20.357
2	4.656	14.547	0.391	19.594
3	5.047	15.813	0.421	21.281
4	4.453	14.938	0.406	19.797
5	4.922	14.875	0.438	20.235
6	4.547	14.906	0.437	19.89
7	4.765	15.110	0.469	20.344
8	4.781	14.922	0.469	20.172
9	4.515	14.922	0.422	19.859
10	4.453	14.797	0.406	19.656

4. Conclusion

In this paper, we proposed a COM component design method for a multithread based image splicing algorithm. This method increases the stability of the splicing system by involving fuzzy visual restriction conditions and, in some degrees, optimizes the algorithm structure and increases the execution efficiency of the algorithm. The proposed method is valuable to promote for real industrial full-scene image splicing.

Acknowledgements

This research was supported by the China National Science Foundation Grant No. 51138003 and Grant No. 61102038, and the Natural Science Foundation of Heilongjiang Province Grant No.QC2011C097.

References

Kanazawa, Y., & Kanatani, K. (2004). Image mosaicing by stratified matching. *Image and Vision Computing*, 22, 93-103.

Liu, D. (2007). Novel seamless image mosaicing algorithm for virtual environment. *International Journal of Computer Mathematics*, 84, 219-229.

Miranda-Luna, R., Daul, C., Blondel, W. C. P. M., Hernandez-Mier, Y., Wolf, D., & Guillemin, F. (2008). Mosaicing of Bladder Endoscopic Image Sequences: Distortion Calibration and Registration Algorithm. *IEEE Transactions on Biomedical Engineering*, 55, 541-553.

Wang, H., Hou, X., Cong, J., & Sun, J. (2010). Four-element relaxation matching algorithm of images based on known initial matching pairs. *Journal of Beijing University of Aeronautics and Astronautics*, 36, 785-788.

Zitová, B., & Flusser, J. (2003). Image registration methods: a survey. *Image and Vision Computing*, 21, 977-1000.